

SOCIO-ENVIRONMENTAL ASPECTS OF THE DEVELOPMENT OF SOLAR ENERGY IN ARMENIA

EcoLur is launching a new study on the topic “Socio-environmental aspects of the development of solar energy in Armenia”. Armenia’s own energy resources are small and consist of only 8.2% of the energy consumed (including gas, oil products, biological resources, etc.). Armenia has a significant solar energy potential. The average annual amount of solar energy flow per square meter of horizontal surface is about 1720 kWh (the average European is 1000 kWh). One fourth of the country’s territory is endowed with solar energy resources of 1850 kWh/m²/year.

Benefits

In recent years, the prices of solar (PV) power technology systems has been decreased by 80%, consequently the volume of capital investments too. Today electricity production in utility-scale solar PV power technology is competitive compared with available power generation other technologies.

Preliminary assessments indicate that in the result of price abatement of PV technology and using funds from Scaling up Renewable Energy Program (SREP) under the Climate Investment Funds (CIFs) or attracting additional mild funding, it is possible to get competitive prices for PV power plants in the energy system. Competitive prices will exclude a negative impact on the consumers, which will enable construction of more powerful plants and cause interest within some of the world famous companies.

In order to develop solar PV technology, the Government of Armenia has applied the Scaling up Renewable Energy Program for Low Income Countries (SREP) under the Climate Investment Funds (CIFs) for the provision of concessional funding. Renewable Energy Investment Project (IP) was approved by the financing organization on June 27, 2014. According to one of the components of the Investment Project, the Climate Investment Funds (CIFs) and the World Bank (WB), allocate grant and soft loans to the Government of Armenia for the construction of the first solar PV plants and for the expansion of the PV technology in the country.

For the preparation of the project, Armenia Renewable Resources and Energy Efficiency Fund (hereinafter R2E2) now implements the Project Preparation activities supported by the WB grant in amount of \$ 2 million within the framework of the Investment Project.

In the framework of the project preparation, the international consulting company made a solar map of Armenia using satellite data. The adjustment is

carried out based on the measurement of solar potential in four locations using the latest available equipment.

6 sites have been selected for the construction of solar PV plants. It is possible to install solar PV plants of about 110 MW total capacity at selected 6 locations. Spanish Ares Engineering has already implemented and submitted feasibility studies for the selected sites. Selected sites are community-owned, and their dimensions and details are provided in feasibility study.

The Government of the Republic of Armenia is planning to announce a tender for the Project implementation to define a minimum tariff. The tender and the construction of six plants will be carried out in several stages. It is envisaged to implement the construction of Masrik 1 plant on the first stage, and the construction of the remaining five stations during the next stages.

The feasibility study of all six sites are for guidance, prepared in the bidding packages for a full or partial submission to investors, are negotiable and can be adjusted during the tender.

Some technical and economic guidance indicators

Masrik 1 – 55 MWp

- Solar resource, GHI per year – 1770 kWh/m²
- Altitude above sea level – 1930 m
- Annual average temperature – 2,7 oC
- Occupied area – 97 ha
- Connection to high voltage line – 110 kV
- Construction of electrical line – 10 km
- CAPEX – \$ 60 mln

Masrik 2 – 19 MWp

- Solar resource, GHI per year – 1770 kWh/m²
- Altitude above sea level – 2000 m
- Annual average temperature – 2,7 oC
- Occupied area – 34 ha
- Connection to high voltage line – 110 kV
- Construction of electrical line – 0,3 km
- CAPEX – \$ 22 mln

Gagarin – 15 MWp

- Solar resource, GHI per year – 1660 kWh/m²

- Altitude above sea level – 1880 m
 - Annual average temperature – 3,3 oC
 - Occupied area – 32 ha
 - Connection to high voltage line – 110 kV
 - Construction of electrical line – 1,8 km
 - CAPEX – \$ 18 mln
- **Talin 2 – 12 MWp**
 - Solar resource, GHI per year – 1870 kWh/m2
 - Altitude above sea level – 1650 m
 - Annual average temperature – 6,8 oC
 - Occupied area – 23 ha
 - Connection to high voltage line – 10 kV
 - Construction of electrical line – 4,8 km
 - CAPEX – \$ 14 mln

Merdzavan – 5 MWp

- Solar resource, GHI per year – 1720 kWh/m2
- Altitude above sea level – 1000 m
- Annual average temperature – 10,2 oC
- Occupied area – 10 ha
- Connection to high voltage line – 6 kV
- Construction of electrical line – 1,6 km
- CAPEX – \$ 7 mln

Dashtadem – 12 MWp

- Solar resource, GHI per year – 1870 kWh/m2
- Altitude above sea level – 1400 m
- Annual average temperature – 6,83 oC
- Occupied area – 23 ha
- Connection to high voltage line – 10 kV
- Construction of electrical line – 5,5 km
- CAPEX – \$ 15 mln

Expected results and benefits

Energy generation

The predicted annual electricity production in all six stations and carbon dioxide reductions are presented in the table below

Location/community name	Installed capacity	Annual electricity produced, /average/ (GW/h)	Reduction of annual carbon dioxide emissions,/averag

	/average/ e/ (MW)		e/ (tons)
Talin 2	10	22	5427
Masrik 1	50	90	22962
Masrik 2	15	30	7515
Gagarin	17	25	6262
Dashtsdem	10	13	3340
Merdzavan	7	11	2922

Social benefits

Job creation opportunities: It is planned to create about 400 short and long-term job opportunities during the construction and operation of solar PV plants. It is also important that educational institutions have significant research potential for the development of solar PV technology. Project implementation will promote further research and progress and will facilitate installation, production and transfer of operational capacity to the local market.

Energy security. Project implementation is targeted towards the development of solar energy state policy and its implementation mechanisms, diversification of economy, strengthening of economic and energy security and independence, energy system reliability improvement, creation of new technologies to promote energy efficiency and renewable energy development and organization of services, as well as reduction man-made impact on environment and human health¹.

The analysis of already existing government decisions, decrees, signed agreements shows that the solar energy sector is provided with state support at the highest level. By 2026, the Armenian government aims to increase the share of solar energy production to 10%, which means that we will have 1.2 billion kWh of electricity from solar power plants, for which it is necessary to have a total installed capacity of 700 MW, including autonomous stations. At present, the calculations and analyzes show that without accumulators (the cost of which is not economically viable at present) the stations will not be able to have a greater share of solar energy, given the existing infrastructure and existing contractual relations with neighboring countries.

¹ <https://r2e2.am/en/2017/06/21/%d5%a1%d6%80%d5%a5%d5%be%d5%a1%d5%b5%d5%ab%d5%b6-%d6%86%d5%b8%d5%bf%d5%b8%d5%be%d5%b8%d5%ac%d5%bf%d5%a1%d5%b5%d5%ab%d5%b6-%d5%af%d5%a1%d5%b5%d5%a1%d5%b6%d5%b6%d5%a5%d6%80%d5%ab-%d5%af%d5%a1%d5%bc-2/>

In order to achieve this goal, \$ 600-700 million will be invested within the framework of the state-private partnership adopted by the Government of the Republic of Armenia, which does not include the relevant development costs of the transmission network (<http://www.minenergy.am/en/page/416>).

Solar thermal energy

In Armenia solar thermal energy is rapidly developing. The private sector is importing both parts for solar water-heating systems, with a view to their subsequent assembly, and complete sets. Currently, the use of solar water-heating systems in Armenia is not only to ensure energy savings, but also has become cost-effective.

In August, 2017 an «Energy Efficient» credit program was started. As of 31.05.2019 in the framework of this program 2685 solar water heaters and 101 solar PV systems were installed in non-gasified communities.

UTILITY-SCALE SOLAR PV PLANTS

For the development of solar energy, according to the 1st stage of «Solar PV plant construction Investment Project» it is foreseen to construct an utility-scale Masrik-1 solar PV power plant with 50-55 MW capacity in Gegharkunik Marz of Armenia. Construction of other 5 PV plants with about 60 MW total capacity will follow-up. On March 21, 2018 the the international tender for the construction of Masrik-1 utility-scale solar PV plant with peak capacity of 55 MW construction was completed. In accordance with terms of the tender the lowest price introduced a consortium composed of «Fotowatio Renewable Ventures» Dutch and «FSL» Spain companies. That's 4,19 \$/cent for 1 kWxh (approx. 20,11 arm.dram) VAT excluded.

On July 18, 2018 the Ministry of Energy Infrastructures and Natural Resources signed a Government Assistance Agreement «On Design, Funding, Construction, Ownership, Possession and Exploitation of Masrik-1 PV power plant in Mets Masrik community of Gegharkunik Region of Armenia». On 25 October, 2018 «FRV Masrik» CJSC (Constructor) got a License on electricity production activity from RA Public Services Regulatory Commission (PSRC) and the volume of total investments was estimated for about 58 mln. USD.

For the production of electricity in solar FV power plants with up to 5 MW capacity 27 companies (totally for about 63 MW) have been licensed, 10 of which (totally for about 8,01 MW) are operated.

Autonomous Solar Energy Producers

As of July 1, 2019 Technical terms were given to 1233 autonomous energy producers with capacity up to 500kW (total capacity 19,3 MW), 1144 of which have already been connected to energy system (total capacity 16,9 MW).

With the proposal of the Ministry of Energy Infrastructures and Natural Resources of RA the PSRC has fixed new provisions for energy sector regulation, particularly new tariff policy and the following maximum annual capacities have been set:

1. Up to 50 MW total capacity for solar power stations till January 1, 2019, and 50 MW more installed capacity during 2019. And there is also an opportunity during 2019 to fill the unreached capacities of the licenses provided till 2019.
2. To provide the licenses for the stations providing energy using other renewable sources without capacity limits till January 1, 2020.

By the decision of the Public Services Regulatory Commission the procedure for determining the electricity tariff produced by the power plants using the renewable energy sources was approved. According to it, the tariff for the solar energy is set on an annual basis.

According to the decision of the Public Services Regulatory Commission N 159-N dated 29 May, 2019 the tariff for the period from 01.07.2019 to 01.07.2020 for solar power plants with up to 5 MW capacity (including) amounts 24.233 dram/ kWxh excluding VAT. For the solar power plants with more than 5 MW installed capacity is reviewed within the framework of separate investment projects. This tariff is determined and revised due to the definite method adopted by the Commission decision N 88-N dated 22 April, 2015. In accordance with the above-mentioned procedure, in the end of every year the tariff for the wind energy is indexed due to the fluctuations in the national currency of Armenia against the USD for a certain period of time and due to the changes of consumer prices in the Republic of Armenia.²

The experts of renewable energy speak about some problems in that sphere. 1. There was no public discussion on the Development of Solar Energy. 2. The access to information is closed and requires clear assessments concerning energy justification and security (stability), which capacities will be displaced out from the current generated field of electricity in Armenia if 400 MWt solar stations should be built, has ENA's ability to buy electricity from solar power plants on a daily and seasonal basis. 3. The question also is how should compensate the losses of the lands of the residents in the impact communities. There high-quality agricultural lands of the 3 villages Mets Masrik, Masrik, and Arpunk were recognized as a public exclusive benefit for the construction of Masrik 1 solar station. That government decision was

² <http://www.minenergy.am/en/page/416>

adopted without alternative proposes of the lands with lower status. 4. The involvement of locals and NGOs in the decision-making process is very weak. 5. The issue of waste of worn-out devices of the solar stations is not resolved and discussed. 6. The business and the Government speak about decreasing poverty in the regions with solar energy. The question is what criteria do they use?